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RELATIVE RESISTANCE OF WHEAT TO BUNT IN THE PACIFIC COAST STATES

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INTRODUCTION

With the development of farming in the Pacific Coast States wheat became the dominant crop. At first most of the wheat was spring sown, and careful seed treatment kept the bunt, or stinking smut (*Tilletia tritici* (Bjerk.) Wint.), under control. When the growing of winter wheat became general, however, it was found that bunt was the most destructive disease of wheat in this region. This was largely owing to the fact that the spores of *T. tritici* live until winter in the soil in this region and bunt tends to increase from year to year.

The heavy annual losses of wheat caused by bunt combined with the ineffectiveness and expense of seed treatment and the possibility of seed injury point to the evident need of a more certain means of bunt control. The most promising possibility appears to be through the development of resistant varieties. Two methods of procedure

are possible: (1) To test as many wheats as are obtainable with the hope of finding varieties naturally resistant to bunt and (2) to use as parents such resistant varieties as may be found and so to develop by hybridization commercially desirable smut-resistant varieties.

This bulletin deals with the first phase of these investigations, namely, a study of a large number of varieties and selections of wheat with reference to their relative resistance to the bunt fungus which causes the principal losses west of the Rocky Mountains.

Acknowledgments are due Dr. George M. Reed, formerly Pathologist in Charge of Cereal-Smut Investigations, Office of Cereal Investigations, for general supervision of the experiments during 1919 and 1920. The writers are indebted to J. Allen Clark, Agronomist in Charge of Western Wheat Investigations, and V. H. Florell, Agronomist, Office of Cereal Investigations, and to agronomists of the agricultural experiment stations of California, Oregon, Washington, and Kansas for furnishing seed for these studies, and to J. C. Bell, Assistant Pathologist, Office of Cereal Investigations, for assistance in the experiments at Moro, Oreg.

The experiments, the results of which are reported herein, were conducted in cooperation with the State agricultural experiment stations of California, Oregon, and Washington. The investigation was planned and conducted by the following persons at their respective stations:

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W. H. Tisdale, Pathologist in Charge of Cereal-Smut Investigations, and J. H. Martin, Agronomist, Western Wheat Investigations, Office of Cereal Investigations, Bureau of Plant Industry, have been responsible for the final preparation of these data for publication.

PREVIOUS INVESTIGATIONS

Other investigators have studied the relative bunt resistance of a limited number of wheats during the past two decades.

Farrer (*4*) [1] reported the results obtained by him in 1900 from inoculating 10 varieties of wheat with spores of the bunt organism, the infection of different varieties ranging from 12 to 95 per cent. Additional results were reported by Farrer in 1904 (*5*). In 1901 he developed through hybridization two varieties of wheat, Florence and Genoa, which, according to Sutton (*10*), possessed a high resistance to bunt.

Tubeuf (*11*), working in Germany, in 1901 and 1902 studied the relative resistance of 23 varieties of wheat to bunt. None of them were totally resistant, but he found a wide range of difference in the degree of their resistance. The Ohio and Ontario varieties

[1] Numbers in italics in parentheses refer to "Literature cited," at the end of this bulletin.

remained almost bunt free, whereas others showed from 25 to 60 per cent of bunt. Kirchner (*7*) in 1908 reported the results of two to four years experiments in Germany with a large number of varieties, including 33 winter varieties of common wheat. Some of these remained almost bunt free, while others produced as much as 33 per cent of bunt.

Darnell-Smith (*2*), of Australia, after repeated experiments came to the conclusion that certain wheats have properties which render them immune from bunt. He mentions Cedar, Florence, and Medeah as being resistant, and states that they have little brush and a horny endosperm. McAlpine (*8*) reported the results obtained by several workers in Australia in determining bunt resistance of wheat varieties and hybrids.

Gaines (*6*), of the Washington Agricultural Experiment Station, reported in 1918 the results of his studies of the comparative bunt resistance of 13 varieties of commercial wheat. He found the Turkey and Alaska varieties to be highly resistant to this disease. Others were more or less highly susceptible.

In 1921 Donkin (*3*), of South Africa, reported the results of experiments in 1918 and 1919 to determine the relative bunt resistance of 20 varieties, including all types of wheats grown in South Africa. He included in his experiments three varieties of durum wheat (*Triticum durum*), three of Polish wheat (*T. polonicum*), two of poulard wheat (*T. turgidum*), one of club wheat (*T. compactum*), and 11 of common wheat (*T. vulgare*), the last consisting of bearded and beardless and early and late varieties. Practically all except the common wheats remained bunt free. One variety of durum wheat, Wild Goose (Arnautka), had 2 per cent of bunt in 1918 in plants cut back when the culms began to form. Among the common wheats Rieti showed an average of 3 per cent of bunt, and other varieties showed 14 to 36 per cent.

PRESENT INVESTIGATIONS

LOCATION AND SCOPE

Preliminary experiments on bunt resistance conducted at the Sherman County Branch Station, Moro, Oreg., in 1918, with the results previously obtained at the Washington station, are the bases for the present investigations.

Experiments were begun, therefore, in the fall of 1918 at Moro and at Pullman, Wash., in cooperation with the Oregon and Washington Agricultural Experiment Stations, to determine on a large scale the relative resistance of wheat varieties to the bunt fungus. These experiments included practically all the commercial wheats of the United States, as well as numerous other varieties and pure-line selections assembled in the wheat-classification nurseries of the Office of Cereal Investigations.

In 1919 the experiments were also confined to Oregon and Washington. The seed of the wheat varieties sown in the classification nurseries at Moro and Pullman in the fall of 1918 was smutted with spores of *Tilletia tritici*. These experiments included 455 varieties and pure-line selections at Moro and 186 at Pullman. Seed of numerous varieties of wheat from Australia and India and about 134

selections of hard red winter wheat also was inoculated, and the plants were grown in the nurseries at Moro in 1919.

In 1920 experiments were conducted in California as well as in Oregon and Washington, and were continued in California in 1921. Artificially smutted seed of the above-mentioned varieties and selections, together with that of additional ones, was sown at Moro, Oreg., Pullman, Wash., and Davis, Calif. Many of the Australian and Indian wheats also were grown in this season. At Davis about 950 varieties and selections were sown. The experiments at Moro were somewhat less extensive, and still fewer varieties and selections were sown at Pullman.

These experiments were continued for two years at each of the three stations, and as nearly as possible the same varieties were included in the sowings at all points. Many of the data obtained at Moro have been published by Stephens and Woolman (*9*) in a bulletin issued by the Oregon Agricultural Experiment Station. Sowings of a limited number of these wheats were made at Corvallis, Hermiston, and Union, Oreg., for the purpose of determining the effects of local conditions on bunt infection. These latter data are not given in the tables because the results obtained did not permit the drawing of accurate conclusions.

METHODS

The seed of these numerous varieties and pure-line selections to be sown at the different stations was obtained as far as possible from identical seed lots and then heavily smutted with spores of *Tilletia tritici* before sowing. The seed, together with dry spores produced in the previous year, was thoroughly shaken in a closed container until the surface of each kernel had a dark smutty appearance. The seed was sown then in single, duplicated, or triplicated rows about 1 foot apart. The sowings were made at each station as nearly as possible at the time when conditions would be conducive to maximum infection. This time, of course, varied considerably, depending on the locality and existing weather conditions. At Davis there was considerably more bunt in these wheats in the crop of 1920 than in that of 1921. This no doubt was caused by the difference in weather conditions at the time of sowing.

In determining the percentages of bunt, counts of the smutted heads and of total heads were made and the percentage of bunt calculated from these figures. In most cases both plant and head counts were made, but the percentages given in the tables in this bulletin are based on head counts only, as these figures seem to indicate more accurately the actual damage caused by the disease.

A list of the varieties and selections grown at Davis, Moro, and Pullman, showing the percentages of bunt infection, is given in Table 1. The list does not include the Australian, Indian, and South African wheats, which are given in Tables 4, 5, and 6, or a number of selections from White Australian.

Most of these wheats were grown during two years. Lack of funds prevented the continuation of these experiments for a longer period. However, results for two years at these widely separated stations should be sufficient to furnish a fairly satisfactory indication of the relative resistance of these wheats to bunt. When a variety or selec-

tion shows bunt infection under any condition it is known to be not immune, and such varieties as are not immune or highly resistant are not considered worthy of continued testing. Immune or highly resistant varieties should be subject to conditions as favorable as possible for bunt infection in order to determine their degree of resistance. These are the wheats desired to serve as resistant parent stocks for hybridization studies.

RESULTS WITH AMERICAN WHEATS

The results obtained in bunt experiments with American wheat varieties and selections are presented in Tables 1 to 4, inclusive. Data on commercial varieties of common wheat are given in Table 1, but results with selections of hard red winter wheat and a few results on head selections of Pacific Bluestem, a white wheat, are given in the text only.

Full data on a few of the most bunt resistant of the selections of hard red winter wheat are presented later in Table 8, under the heading "Resistant varieties."

Data similar to those for common wheat are presented for club wheats in Table 2 and for durum wheats in Table 3. Results of experiments on minor wheat groups, such as emmer, spelt, poulard wheat, Polish wheat, and einkorn, are shown in Table 4 and the accompanying text.

COMMON WHEATS

In preparing the data the common wheats are separated into "Commercial varieties" (Table 1) and "Selections" (not tabulated).

COMMERCIAL VARIETIES

The percentages of infected heads in the commercial American varieties of common wheat are shown in Table 1. The common wheats are here divided into four commercial classes (hard red spring, hard red winter, soft red winter, and white). The recognized varieties are listed in alphabetical order, following the nomenclature used in the "Classification of American Wheat Varieties," by Clark, Martin, and Ball (*1*). All names of synonymous varieties are listed together in alphabetical order or in the order of their Cereal Investigations (C. I.) numbers under the recognized varietal names. Data are shown for only the varieties and selections which have been grown in the bunt experiments during two or more station years.

The varieties consist largely of those assembled for the study of wheat classification by members of the Office of Cereal Investigations. Many were grown from seed selected from individual heads in previous seasons and thus are pure-line selections, whereas others represent merely the mass variety. It may be possible, therefore, that other pure lines of these varieties would show different degrees of bunt infection. Two or more strains of nearly all varieties were grown in the bunt experiments, so that the behavior of the variety as a whole is fairly well indicated.

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown [1]
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
HARD RED SPRING WHEATS								
Champlain:								
Pringle's Champlain	3316	75.1	27.6	48.0	51.0			50.4
Do	4782	64.3	11.6	29.0	32.0			34.2
Do	6160	60.5	42.9					51.7
Do	6171	76.4	51.7					64.1
Chul:								
Chul	2227	83.1	61.0	76.0	100.0	46.7	68.9	72.6
Yantagbay	2404	85.3	53.7	69.0	85.0			73.3
Converse:								
Red Russian	4141	75.4	31.1	62.0		42.1	75.5	57.2
Dakota:								
Dakota	3083	29.4	10.1	32.0	67.3			34.7
Dixon:								
Smooth Humpback	6049	71.1	20.5					45.8
Early Red Fife:								
Early Red Fife	4932	64.5	7.4	72.0	83.5	38.1	83.6	58.2
Erivan:								
Erivan	2397	85.4	44.0	30.0		61.5	69.2	58.0
Fretes:								
Fretes	1596	81.0	55.0	85.0	88.0	69.7	54.8	72.3
Fretes selection	1596–1	88.0	54.6					71.3
Do	1596–4	88.6	65.2					76.9
Ghirka:								
Early Russian	4933	23.9	2.2	21.0	82.0			32.3
Ghirka Spring	1517	20.1	2.1	22.0	80.0	4.8	77.6	34.4
Glyndon:								
Glyndon	2873	66.9	22.0	44.0	63.0	4.3	60.9	43.5
Do	4143	56.5	13.2	54.0	94.0			54.4
Haynes Bluestem:								
Bolton	3023	58.4	13.4	75.0	60.0			51.7
Haynes Bluestem	2874	73.2	37.6	54.0	79.0	50.9	63.8	59.8
Marvel	3082	54.5	25.5	33.0	60.5			43.4
Do	5278	29.6	3.8	58.0	66.2			39.4
Humpback:								
Humpback	3690	40.8	9.1	14.0		13.4	50.5	25.6
Do	4379	36.6	4.4	18.0				19.7
Do	4380	40.9	4.4	59.0	63.5			42.0
Do	6048	78.4	50.6					64.5
World Beater	3700	25.7	1.7	40.0	70.0			34.4
Huron:								
Huron	3315	76.9	54.0	58.0		62.8	77.1	65.8
Do	4350	84.6	50.5	78.0	85.0			74.5
Do	4935	65.8	23.1	47.0				45.3
Do	5527	76.3	53.1	36.0				55.1
Huston:								
Grass	6044	74.8	56.6					65.7
Huston	5205	85.9	37.6	17.0	88.0	77.6	73.3	63.2
Do	5208	91.8	45.4	60.0	70.0			66.8
Do	5209	88.8	40.6	71.0	73.0			68.4
Swamp	6043	75.9	81.3					78.6
Java:								
Early Java	4395	39.5	5.6	71.0	52.5			42.2
Do	4966	65.8	19.8	85.0		45.7	6.1	44.5
Swedish	4394	52.6	4.7	38.0	53.0			37.1
Kinney:								
Kinney	5189	84.5	39.8	95.0	94.5	53.9	78.8	74.4
Do	5192	77.5	28.4	55.0	90.0			62.7
Do	5195	78.6	26.2	80.0	78.5			65.8
Do	6025	80.3	26.6					53.5
Kitchener:								
Kitchener	4800	55.2	7.6	38.0	85.0	41.7	42.2	45.0
Kota:								
Kota	5878	87.2	28.5	11.0	26.3	53.9	79.5	47.7
Ladoga:								
Bastard	4291	78.1	56.9	20.0	23.0			44.5
Do	4972	77.1	52.9	45.0	0			43.8

[1] These averages are directly comparable only when those based on data from the same station years are considered.

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
HARD RED SPRING WHEATS—contd.								
Ladoga—Continued.								
Ladoga	4795	74.3	42.3	27.0	-------	28.0	51.3	44.6
Do	6166	30.4	13.3	-------	-------	-------	-------	21.9
Do	6169	68.7	51.5	-------	-------	-------	-------	60.1
Do	6170	70.4	54.5	-------	-------	-------	-------	62.5
Spring Turkey	4154	-------	-------	21.0	45.0	-------	-------	33.0
Do	6012	83.9	58.3	15.0	56.0	-------	-------	53.3
Marquis:								
Marquis	3641	40.0	3.7	32.0	40.0	17.2	49.5	30.4
Do	5294	38.0	4.2	-------	-------	-------	-------	21.1
Do	5954	52.3	2.2	75.0	45.0	-------	-------	43.6
Do	5994	-------	-------	67.0	34.0	-------	-------	50.5
Do	6173	35.0	13.6	-------	-------	-------	-------	24.3
Norka:								
Norka	4377	82.2	55.9	72.0	22.0	-------	-------	58.0
Pioneer:								
Pioneer	4324	59.7	8.7	4.0	26.3	31.7	52.4	30.5
Power:								
Power	3025	15.1	6.4	82.0	81.5	-------	-------	46.3
Do	3697	57.3	7.0	47.0	80.0	35.7	81.3	51.4
Prelude:								
Prelude	4323	-------	-------	72.0	-------	65.8	48.6	62.1
Preston:								
Preston	2958	42.5	8.4	15.0	94.0	37.1	54.5	40.0
Do	3328	63.3	13.0	38.0	85.0	-------	-------	49.8
"Scotch Fife"	4393	44.4	9.0	41.0	56.0	-------	-------	37.6
"Velvet Chaff"[2]	3081	60.0	3.7	38.0	60.0	-------	-------	40.4
Do	3318	49.0	3.7	88.0	60.0	-------	-------	50.2
Red Fern:								
Red Fern	4936	59.2	9.8	61.0	55.0	28.2	66.6	46.6
Do	4971	44.2	11.6	10.0	33.0	-------	-------	24.7
Do	5181	57.3	10.7	2.6	60.0	-------	-------	32.7
Red Fife:								
Red Fife	3328	53.3	27.1	35.0	-------	73.6	46.9	47.2
Do	5872	89.5	34.4	77.0	76.5	-------	-------	69.4
Ruby:								
Ruby	6047	25.6	4.0	5.0	-------	-------	-------	11.5
Rysting:								
Rysting	3022	62.2	17.0	52.0	88.0	83.8	-------	60.6
Stanley:								
Stanley	4769	73.4	30.7	83.0	75.0	21.7	75.0	59.8
Do	4796	66.1	30.1	67.0	75.0	-------	-------	59.6
Do	4973	92.6	44.9	59.0	73.5	-------	-------	67.5
Annual average	------	62.9	27.3	48.2	64.7	43.6	62.0	50.0
Two-year station average	------	45.1		56.5		52.8		-------
HARD RED WINTER WHEATS								
Alton:								
Ghirka Winter	1438	68.9	4.4	71.0	83.5	81.1	88.4	66.2
Do	4458	-------	-------	72.0	81.0	-------	-------	76.5
Newton	1442-350	60.1	3.3	90.0	85.0	-------	-------	59.6
Bacska:								
Bacska	6156	24.9	2.8	-------	-------	-------	-------	13.9
Beloglina:								
Beloglina	1543	7.5	0	25.0	30.2	-------	-------	15.7
Do	1667	4.3	1.4	13.0	20.5	-------	-------	9.8
Do	2239	50.2	4.7	90.0	60.0	-------	-------	51.2
Eureka	5170	-------	-------	61.0	93.0	-------	-------	77.0
Hussar:								
Red Hussar	4843	0	0	0	0	0	0	0
Kanred:								
Kanred	5146	9.2	3.8	0	11.5	.8	32.4	9.6
P-1066	5879	2.0	0	-------	-------	-------	-------	1.0
P-1068	5880	4.9	5.0	-------	-------	-------	-------	5.0
Minturki:								
Minturki	6155	.2	0	-------	-------	-------	-------	.1
Rieti:								
Rieti	2578	.2	0	.5	0	-------	-------	.2

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
HARD RED WINTER WHEATS—contd.								
Turkey:								
Crimean	1437	37.0	5.5	50.0	66.6			39.8
Kharkof	1442	5.3	.6	5.0	6.0	2.8		3.9
Turkey	1558	10.8	.05	9.0	8.5			7.1
Do	3055	0	0	1	0			.3
Do (Washington No. 326)	6175	8.6	.3			8.0	10.3	6.8
Turkey (Arizona No. 3651)		12.9	8.2					10.6
Annual average		17.1	2.2	34.8	39.0	18.5	32.8	22.7
Two-year station average		9.7		36.9		25.7		
SOFT RED WINTER WHEATS								
Bald	5329	63.3	21.6	68.0	87.3	85.1	64.7	65.0
Bearded Winter Fife:								
Bearded Winter Fife	4204	82.6	15.5	99.0	92.5	91.0	80.7	76.9
Big Frame:								
Big Frame	6184	31.4	.2					15.8
Buffum No. 17:								
Buffum No. 17	3330	54.8	3.0	93.0	88.5	97.2	97.1	72.3
Do	5875	53.2	7.2	95.0	84.0			59.9
China:								
China	180	38.1	3.1	85.0	75.0			50.3
Do	4888	44.2	.8	80.0	66.0	78.1	75.5	57.4
Do	5669	46.8	5.7	81.0	80.0			53.4
Mortgage Lifter	3473	65.0	4.4	96.0	74.5			60.0
Pennsylvania Bluestem	4816	56.8	1.5	92.0	91.0	96.1	81.5	69.8
Do	5917	31.5	1.0	71.0	78.0			45.4
"Perfection"	5729	66.4	8.9	94.0	89.0			64.6
"Trumbull"	5601	2.6	.2	15.0	22.0			10.0
Climax:								
K. B. No. 2	4835	56.2	1.6	83.0	83.5	96.0	78.8	66.5
Do	5955	58.2	2.8	92.0	84.0			59.3
Cox:								
Cox	6149	45.2	5.1					25.2
Currell:								
Currell's Prolific	2906	68.0	15.6	83.0	85.0	95.0	77.3	70.7
Do	3326	76.8	13.8	100.0	78.0			67.2
Do	4889	75.2	11.9	95.0	93.0			68.8
Do	5765			89.0	94.0			91.5
Do	5766	67.9	10.3	94.0	93.0	98.9	72.8	72.8
Do	5904	65.2	3.1	98.0	96.0			65.6
Diamond Grit:								
Diamond Grit	3385	82.0	15.0	91.0	78.0			66.5
Diehl-Mediterranean:								
Blue Ridge	4887	33.4	4.3	81.0	66.5			46.3
Diehl-Mediterranean	1395	27.8	1.9	51.0	69.0			37.4
Do	4494	73.8	7.4	98.0	81.0	96.3	95.2	75.3
Eclipse	3396	28.1	3.5	74.0	39.0	76.0	62.2	47.1
Do	5674	25.9	3.6	47.0	73.0			37.4
Do	5930	23.5	2.3	86.0	70.5			45.6
Imperial Amber	5931	49.7	14.0	63.0	83.5			52.6
Fleming:								
Fleming	5996	67.8	4.9					36.4
Fulcaster:								
Bearded Purplestraw	1911	77.3	15.1	93.0	39.0			56.1
Do	5630	69.5	5.5	63.0	83.0			55.3
Blue Ridge	5270	74.3	14.1	80.0	68.0			59.1
Dietz Longberry	5570	65.9	24.2	69.0	85.0			61.0
Egyptian Amber	4853	72.3	6.7	89.0	77.5			61.4
Fulcaster	3406	66.3	27.4	92.0	49.0	96.8	73.2	67.5
Do	4862	33.5	15.6	84.0	66.0			49.8
Do	5767	77.5	41.6	95.0	78.5			73.2
Do	6162	48.8	22.0					35.4
Marvelous	5685	67.5	12.0	76.0	71.0			56.6
Do	5689	67.3	20.6	95.0	65.0			62.0
Miracle	5665			94.0	11.3	95.1	86.1	71.9
Do	5777	68.3	19.3	58.0	50.0			48.6
New Marvel, or Goose	6042	77.7	75.1					76.4

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
SOFT RED WINTER WHEATS—contd.								
Fulcaster—Continued.								
Price's Wonder	5927	73.5	14.4	91.0	96.0	91.7	89.3	76.0
Red Wonder	5373	74.6	31.1	55.0	67.0			56.9
Do	5780	61.4	19.9	90.0	80.0			62.8
Stoner	2980	58.1	17.5	90.0	84.0	96.7	89.3	72.6
Do	5559	70.8	15.9	95.0	76.0			64.4
Fultz:								
Fultz	3416	73.8	16.2	99.0	90.0	97.1	75.5	75.3
Do	5633	78.3	11.8	93.0	71.6			63.7
Do	5659	53.7	13.8	93.0	95.0			63.9
Fultzo-Mediterranean:								
Four-Row Fultz	4809	54.0	14.7	86.0				51.6
Fultzo-Mediterranean	4811	50.8	4.8	87.0	75.5	91.3	81.3	65.1
Do	5576	47.8	13.9	63.0	46.0			42.7
Gladden:								
Gladden	5577	71.6	3.0	80.0	85.0	91.4	77.6	68.1
Do	5644	51.2	2.5	83.0	83.0			54.9
Gluten:								
Gluten B 86	4856	60.6	4.5	98.0	90.0	94.9	72.8	70.1
Do	5613	68.9	1.7	87.0	89.0			61.7
Do	5794	64.3	1.3	83.0	79.5			57.0
Goens:								
Dunlap	4851			74.0	66.0			70.0
Goens	4857			76.0	94.0	92.2	55.9	79.5
Do	5945			90.0	88.5			89.3
Grandprize:								
New Genesee	5800	46.6	1.0	83.0	56.0			46.7
St. Louis Grandprize	4876	53.2	0	87.0				46.7
Do	5393	26.2	0	80.0	77.2	83.6	62.2	54.9
Do	5913	33.7	0	74.0				35.9
Gipsy:								
Defiance	5305	86.5	26.7	96.0	91.5			75.2
Farmers Friend	5793	29.0	3.4	61.0	34.0			31.9
Grains o' Gold	5334	54.4	5.7	77.0	75.0			53.0
Gipsy	3436	63.9	19.3	61.0	79.3	93.4	65.1	63.7
Do	5579	60.0	2.9	96.0	89.0			62.0
Do	5772	64.1	13.3	91.0	85.0			63.4
Lebanon	5585	68.2	1.9	88.0	80.0			59.5
Niagara	5307	47.0	4.5	97.0	77.3			56.5
Reliable	5325	43.3	29.1	82.0	74.0			57.1
Do	5781	79.2	6.4	97.0	90.5			68.3
Do	5828	80.8	20.1	97.0	86.5			71.1
Golden Cross	5180	74.7	17.1	35.0	31.5	86.4	66.0	51.8
Harold	6005	62.4	25.8					44.1
Harvest Queen:								
Harvest Queen	5314	80.3	15.7	99.0	95.8			72.7
Kessinger	5615	79.8	16.1	99.0	94.0	94.7	75.8	76.6
Red Cross	4882	82.3	25.4	98.0	92.0	94.3	89.0	80.2
Do	5957	77.0	19.6	93.0	95.0			71.2
Illini Chief:								
Illini Chief	4492	76.0	18.2	75.0	96.0	93.3	86.5	74.2
Do	5406	63.6	15.6	90.0	90.3			64.9
Do	5956	65.1	14.7	95.0	80.0			63.7
Imperial Amber:								
Imperial Amber	4860	39.2	2.3	73.0	73.5			47.0
Do	5338	61.9	4.4	97.0	84.0	96.1	88.9	72.1
Jones Fife:								
Burbank Super	5544	73.5	7.1	75.0	86.0	96.0	88.7	71.1
Canadian Hybrid	5763	73.4	11.3	92.0	66.5			60.8
Crail Fife	4162	74.3	17.2	84.0	91.0	94.8	68.8	71.7
Fishhead	5939	37.4	6.6	85.0	70.0	95.4	82.0	62.7
Jones Fife	4468	57.2	3.1	77.0	51.0	89.3	70.4	58.0
Do	5236	61.5	3.1	78.0	66.0			52.2
Do	6177	77.7	12.4					45.1
Jones Paris Prize	3356	43.2	1.1	83.0	94.0			55.3

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
SOFT RED WINTER WHEATS—contd.								
Leap:								
Leap's Prolific	4823	57.9	31.8	87.0	99.0			68.9
Do	5634			45.0	65.0			55.0
Do	5662	59.0	21.4	80.0	92.0	90.2	74.1	69.5
Do		76.8	4.7					40.8
Lofthouse:								
Lofthouse	3275	25.7	3.7	78.0	76.0	84.7	74.4	57.1
Long Amber:								
Long Amber	3458	54.0	17.0	77.0	79.0			56.8
Mammoth Red:								
Mammoth Red	2008	72.2	6.6	77.0	62.5			54.6
Do	5587	70.9	3.5	88.0	84.0			61.6
Mealy:								
Mealy	3358	74.1	8.2	97.0	68.0	94.0	76.7	69.7
Do	5725	77.8	6.7	97.0	82.5			66.0
Do	5916	71.5	5.5	91.0	88.0			64.0
Mediterranean:								
Lebanon	3456	37.8	11.2	67.0	94.0			52.5
Lehigh	3457	56.3	7.4	74.0	69.0			51.7
Mediterranean	5303	44.7	3.7	90.0	77.0	89.4	61.9	61.1
Do	5364	65.7	21.3	84.0	94.0			66.3
Do	5776	61.8	8.6	85.0	91.0			61.6
Miller's Pride	4865	40.8	3.0	50.0	67.0			40.2
Do	5932	4.8	1.1	14.0	43.0			15.7
Missouri Bluestem	1912	62.3	9.1	85.0	89.0			61.4
Rocky Mountain	1930	75.4	28.6	89.0	95.0			72.0
Minhardi:								
Minhardi	5149	49.3	16.0	57.0	79.0			50.3
New Columbia	5946	77.6	30.9	91.0	70.0	70.0	60.6	66.7
Nigger:								
Nigger	5366	77.7	10.4	77.0	91.7	81.8	72.7	68.6
Do	5689	68.2	8.9	78.0	84.7			60.0
Do	5778	76.2	8.9	98.0	80.0			65.8
Do	6164	46.4	37.3					41.9
Winter King	3546	3.8	0	40.0	11.1	39.6	38.2	22.1
Odessa:								
Odessa	3003			93.0	94.0			93.5
Do	3274			51.0	93.0	65.6	61.3	67.7
Do	4473	.3	0					.2
Do	4475	5.6	0	56.0	57.0			29.7
Do	6027	40.2	1.4					20.8
Do	6035	7.2	0					3.6
Ohio No. 5309	5388	24.0	1.1	73.0	72.0			42.5
Ontario Wonder:								
Ontario Wonder	3483	64.9	11.5	79.0	92.5	97.3	84.3	71.6
Do	5690	70.1	14.1	81.0	95.7			65.2
Do	5935	53.8	3.8	72.0	92.5			55.5
Penquite:								
Penquite's Velvet Chaff	4877	71.2	22.1	93.0	93.0			69.8
Velvet Chaff	5783			67.0	80.0			73.5
Do	5948	46.6	23.0	80.0	80.0	91.8	86.3	68.0
Poole:								
Harvest King	4894	60.6	5.3	80.0	72.5	84.3	71.1	62.3
Do	5647	56.1	.9	85.0	86.0			57.0
Do	5680	63.0	4.2	77.0	78.0			55.6
Do	6183	46.1	3.6					24.9
Hedge Prolific	4859	79.2	11.5	86.0	93.0			67.4
Mortgage Lifter	5929	35.5	1.9	73.0	65.0			43.9
Nissley	4805	73.7	5.4	93.0	87.5			64.9
Poole	3488	65.5	14.6	92.0	90.5	92.2	81.3	72.7
Do	5370	73.8	7.6	93.0	72.0			61.6
Do	5593	86.1	24.3	90.0	89.5			72.5
Red Fultz	3413	71.7	9.2	93.0	40.0			53.5
Royal Red Clawson	5936	67.9	13.8	85.0	85.0			62.9
Prosperity:								
American Bronze	4624	61.0	27.1					44.1
Do	5380	69.8	3.6	82.0	84.0	75.6	74.3	64.9
Do	5762	71.5	3.7	79.0	85.8			60.0
Do	5901			60.0	78.5			69.3

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C.I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
SOFT RED WINTER WHEATS—contd.								
Purplestraw.								
Alabama Bluestem	5302	93.5	60.6	99.0	37.0			72.5
Do		89.8	75.6					82.7
Purplestraw	1915	89.1	86.1	90.9	96.0	72.0	78.6	85.5
Do	5595	94.8	60.8	97.0	87.5			85.0
Do	5815	90.1	55.3	95.0	97.0			84.4
Red Chief:								
Early Red Chief	3392	44.0	.6	40.0	78.0			40.7
Do	5951	44.1	.8	44.0	77.0	61.4	57.9	47.5
Red Clawson:								
Early Red Clawson	3393	71.5	4.7	95.0	82.0			63.3
Do	5640	48.7	11.7	89.0	79.0	76.7	79.9	64.2
Red May:								
Beechwood	4886	77.8	18.7	69.0	87.7			63.3
Do	5566	73.4	16.1	79.0	75.0			60.9
Early Harvest	4334	81.9	8.6	91.0	90.3			68.0
Early Ripe	3394	52.7	8.4	63.0	78.0			50.5
Do	5319	70.6	13.2	84.0	90.0			64.5
Enterprise	4854	66.5	12.8	80.0	90.0			62.3
Jones Longberry	5339	53.4	19.5	91.0	80.0	95.0	82.1	70.2
Michigan Amber	1969	64.8	5.8					35.3
Do	4864	51.8	16.0			82.7	79.7	57.6
Michigan Wonder	5321	65.3	11.8	85.0	86.6			62.2
Do	5589	52.2	20.5	89.0	90.0			62.9
Orange	4868	70.5	11.1	94.0	96.5			68.0
Pride of Indiana	5324	64.8	22.0	68.0	85.6			60.1
Red May	5336	77.2	8.4	89.0	91.5	95.1	84.0	74.2
Do	5596	75.6	9.2	80.0	82.0			61.7
Do	5731	74.3	7.4	96.0	65.0			60.7
Red Rock:								
Red Rock	5597	55.8	12.9	75.0	81.0			56.2
Do	5976	49.2	4.8	65.0	76.0	87.2	61.0	57.2
Do	6007	69.1	15.7					42.4
Red Russian:								
Red Russian	4509	38.4	2.8	83.0	90.5			53.7
Do	4681	30.5	2.5	83.0	80.0	86.6	75.0	59.6
Red Wave:								
Jones Red Wave	5582	59.9	5.4	63.0	91.0			54.8
Red Wave	3500	72.3	4.4	80.0	96.0	91.2		68.8
Do	4872	58.5	7.7	71.0	58.0			48.8
Rochester:								
Rochester Red	5312	63.6	13.5	97.0	33.5	91.5	84.4	63.9
Do	5693	58.4	1.4	78.0	62.0			50.0
Shepherd's Tennessee Fultz	3314	66.1	9.0	60.0	88.0			55.8
Rudy:								
Queen of New York	3493	75.5	4.6	93.0	79.0			63.0
Rudy	4873	62.6	7.6	87.0	83.0	28.9	78.9	58.0
Do	5625	67.9	4.3	81.0	75.0			57.1
Do	5963	67.0	4.1	98.0	68.3			59.4
Rupert:								
Rupert's Giant	5920	56.2	2.5	93.0	64.0	93.8	72.4	63.7
Rural New Yorker No. 6:								
Red Hussar	3496	35.0	2.0	73.0	75.0			46.3
Do	4493	78.1	14.3	76.0	89.0			64.4
Rural New Yorker No. 6	5921	67.0	.4	66.0	70.5			51.0
Rural New Yorker No. 57:								
Rural New Yorker No. 57	3516	87.7	17.2	92.0	94.0	96.1	79.7	77.8
Do	4505	71.5	6.1	93.0	93.5			66.0
Do	5151	55.2	10.9	83.0	71.0			55.0
Velvet Chaff	5784	59.8	23.0	97.0	94.0			68.5
Russian:								
Russian	5737			30.0	18.0			24.0
Russian Red	5928	78.3	4.2	73.0	94.0			62.4
Schlanstedt:								
Sommerweizen	4646	75.8	28.5	65.0	72.0	42.0	73.1	59.4
Shepherd:								
Shepherd	6163	71.6	12.5					42.1

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
SOFT RED WINTER WHEATS—contd.								
Sibley:								
Sibley New Golden	3520	46.8	0	74.0	64.0			46.2
Do	5666	28.7	1.0	57.0	44.0			32.7
Silversheaf:								
Jones Silversheaf Longberry	2496	80.4	49.5	95.0	60.0	99.5	98.6	80.5
Do	5922	67.3	5.5	90.0	71.0			58.5
Sol:								
Sol	6009	66.5	4.0	97.0	70.0			59.4
Squarehead:								
English Squarehead	5234	19.9	.3	35.0	66.6	73.6	64.9	43.4
Do	5235	20.8	.9	81.0	62.0			41.2
Squareheads Master:								
Brown Squarehead	4298	30.7	.9	78.0	66.0		77.0	50.5
Do	4649	30.1	1.5	65.0	70.0			41.7
Do	5900	43.0	1.1	59.0	93.0			49.0
Do	6187	47.7	1.7					24.7
Treadwell:								
Treadwell	5933	75.9	7.5	76.0	80.5			60.0
Triplet:								
Triplet	5408	39.2	7.1	91.0	80.0	89.3	87.0	65.6
Valley:								
Indiana Swamp	4833	68.1	2.2	95.0	67.0			58.1
Russian Amber	4874	52.7		85.0	66.0			67.9
Valley	5391	62.7	1.5	93.0	81.5			59.7
Do	5923	54.8	9.4	79.0	65.5	92.5	89.1	65.1
Virginia:								
Virginia	5606	93.5	24.9	95.0	96.0			77.4
Wheedling:								
Wheedling	4846	73.7	3.7	86.0	90.0			63.4
Winter Chief:								
Winter Chief	4878	67.1	5.5	91.0	78.0			60.4
Wisconsin Pedigree No. 40:								
Wisconsin Pedigree No. 40	5807	74.8	7.5	86.0	82.0			62.6
Wyandotte:								
Wyandotte Red	3549	77.6	17.2	99.0	96.0			72.5
Do	5696	25.0	2.7	98.0	81.6	93.8	75.0	62.7
Zimmerman:								
Zimmerman	2907	75.0	20.0	97.0	88.6	94.9	64.9	73.4
Do	4496	79.8	21.8	100.0	87.0			72.2
Do	4620	91.4	74.2	84.0	94.8			86.1
Annual average		60.0	12.0	81.4	77.8	86.9	76.0	58.8
Two-year station average		36.0		79.6		81.5		
WHITE WHEATS								
Allen:								
Red Allen	5407	29.3	1.4	11.0		3.8	6.2	10.3
Do	6186	10.8	3.4					7.1
Arcadian:								
Early Arcadian	3390	57.8		97.0	70.0	84.2	81.8	78.2
Do	4220	58.3	1.0	85.0	75.0			54.8
Do	5871	57.4	10.0	88.0	70.0			56.4
Baart:								
Columbia	5279	88.5	44.2	38.0	36.0	61.4	73.7	57.0
Diener No. 2	6188	89.2	48.9					69.1
Diener No. 16	6189	94.3	55.4					74.9
Diener No. 18	6190	93.6	55.2					74.4
Early Baart	1697	76.5	55.0	32.0	100.0	45.0	66.5	62.5
Do	4206	88.8	42.4	18.0	73.0			55.6
Bobs:								
Bobs	4710	83.7	65.2					74.5
Do	4990			69.0	50.0			59.5
Bobs No. 1		94.9	72.1					83.5
Bobs No. 2		90.6	57.2					73.9
Bobs No. 3		88.1	63.9					76.0
Challenge:								
Webb Challenge White	4683	65.1	11.9	37.0	75.0			47.3
Do	4684–B	85.3	41.8	15.0	91.0			58.3
Do	5227–B	74.8	32.8	87.0	87.4		85.7	73.5

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C.I. No.	Percentages of bunted heads						
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		Average in all station years when grown
		1920	1921	1919	1920	1919	1920	
WHITE WHEATS—continued								
Dawson:								
Dawson Golden Chaff	3342	79.9	19.9	86.0	97.0	89.4	77.9	75.0
Do	4850	78.1	15.8	98.0	89.0			70.2
Honor	6161	76.9	17.5					47.2
Golden Bronze	3332	73.8	13.4	94.0	95.0			69.1
Defiance:								
Defiance	4347	92.8	50.6	97.0	83.0			80.9
Do	4354	34.1	3.3	71.0		55.8	41.4	41.1
Do	4605	63.6	28.5					46.1
Do	4764	79.6	52.5	65.0	50.0			61.8
Do	6077	88.2	73.1					80.7
Do	6172	82.5	49.3					65.9
Democrat:								
Democrat	3384	63.0	2.7	93.0	86.3			61.3
Dicklow:								
Big Four	6020	90.9	81.3					86.1
Dicklow	3663	89.5	71.6	75.0		67.3	49.9	70.7
Do	5285	85.5	65.0	99.0				83.2
Do	5898	96.7	78.5	76.0				83.7
Do	6159	89.5	80.1					84.8
Eaton:								
Eaton	4362	78.5	25.8	42.0	84.5	93.7	76.1	66.8
Do	4682	74.6	24.0	96.0	82.5			69.3
Do	5219-B	76.7	31.2	24.0	90.5			55.6
Emerald:								
Emerald	4397	76.9	30.4	78.0				61.8
Federation:								
Federation	4734	78.3	57.3	66.0				67.2
Foisy:								
Foisy	5242	74.1	15.8	83.0	94.3	91.8	85.8	74.1
Do	5246	74.4	23.8	71.0	88.0			64.3
Do	5253	84.3	53.2	97.0	85.0	56.4	21.9	66.3
Oregon Golden Chaff	5283	71.7	22.6	82.0	68.0			61.1
Oregon Red Chaff	4069	93.4	75.0	32.0		42.3	76.2	63.8
Galgalos:								
Galgalos	2398	14.9	9.2	49.0	56.7	81.9	29.4	40.2
Do	4467	11.1	7.7	24.0	60.8			25.9
Genesee Giant:								
Farmers Trust	6003	68.6	11.3					40.0
Genesee Giant	1744	69.8	2.7	94.0	60.0	94.5	73.2	65.7
Do	4453	66.6	.5	88.0	62.5			54.4
Giant Squarehead	5273	43.2	0	80.0	73.0			49.1
Golden Cross	3433	47.8	4.1	83.0	72.0			51.7
Goldcoin:								
Fortyfold	6176	41.0	3.4					22.2
Goldcoin	2996	42.5	.3	87.0	67.5	79.6	49.9	54.5
Do	4230	38.8	.9	60.0	60.0			39.9
Do	4500	40.9	4.0	39.0	72.0			39.0
Gypsum:								
Colorado Special	4761	91.8	76.0	71.0		72.7	55.0	73.3
Do	4762	95.0	62.2	78.0	91.0			81.6
Do	4928	94.6	39.0	15.0	90.0			59.7
Hard Federation:								
Hard Federation	4980	86.3	32.7	62.0	50.0			57.8
Indian:								
Indian	4489	92.1	64.2	46.0		71.4	49.7	64.7
Do	6015	83.7	62.1					72.9
Jumbuck:								
Jumbuck	4608	88.9	54.4	8.0	76.0	19.3	35.7	47.1
Kofod:								
Kofod	2097	88.6	37.4	60.0	76.0			65.5
Do	4337	35.8	2.3	.3	25.7	29.6	21.6	19.2
Do	4339	26.5	1.7	0	7.7			9.0
Do	4655	93.2	73.6					83.4
Link:								
Missing Link	4866	69.7	1.0	93.0	82.5	97.8	87.6	71.9
Mammoth Amber:								
Jones Mammoth Amber	3355	44.6	3.3	79.0	79.0			51.5
Do	5911	26.6	1.6	72.0	64.0	70.4	64.3	49.8

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
WHITE WHEATS—continued								
Martin:								
Martin Amber	3587	59.0	6.5	97.0	83.0			61.4
Do	4463	0	0	0	0		0	0
Do	4636	51.0	11.9	90.0	77.5	85.7	44.4	60.1
Do	6029	54.7	2.6					28.7
Mexican Bluestem:								
Mexican Bluestem	6004	74.0	56.2					65.1
Do	6008	90.9	59.1					75.0
New Zealand:								
New Zealand	6022	83.7	48.4					66.1
Oatka Chief:								
Oatka Chief	3481	48.4	4.7	85.0	79.6			54.4
Pacific Bluestem:								
Pacific Bluestem	4067	93.1	47.7	28.0	94.5	80.6	64.0	68.0
Do	4606	84.4	29.7	51.0	65.0			57.5
White Australian	3019–3	93.7	47.6					70.7
Do	3019	87.0	38.3	52.0	46.0			55.8
White Chile	6033	92.1	49.4					70.8
Pilcraw:								
Pilcraw Enormous	5540	93.1	68.7	24.0	62.0	66.8	39.0	58.9
Do	5869	89.6	63.8	81.0	85.0			79.9
Do		93.4	67.4					80.4
Pride of Genesee:								
Pride of Genesee	3365	85.3	20.1	96.0	91.0			73.1
Prohibition:								
Prohibition	4068	89.1	50.2	96.0	97.0	83.0	71.9	81.2
Do	5225	85.6	37.0	100.0	99.0			80.4
Do	5226	83.8	29.5	100.0	99.0			78.1
Propo:								
Propo	1970	87.6	71.1	62.0	63.3	61.6	38.3	64.0
Do	4330	91.4	61.7	49.0	66.0			67.0
Quality:								
Quality	6157	3.4	5.3					4.4
Regenerated Defiance:								
Regenerated Defiance	3703	66.4	42.8	50.0		63.7	73.9	59.4
Do	4763	81.9	47.6	50.0				59.8
Do	5265	86.3	47.9	53.0	81.0			67.1
Do	6024	37.7	7.4					22.6
Do	6030	76.4	48.7					62.6
Do	6034	83.3	49.2					66.3
Rink:								
Rink	5866	94.3	66.0	96.0	91.0	91.6	85.8	87.5
Do	5867	95.8	60.6	96.0	68.0			80.1
Do	5868	93.4	50.3	58.0	91.5			73.3
Saskatoon	4288	74.2	34.5	71.0	86.0	32.1	58.3	59.4
Do	4962	61.4	18.5	68.0	65.7			53.4
Satisfaction:								
Satisfaction	5938	58.1	16.5	92.0	88.0			63.7
Smith's Rust Proof	3588	65.5	29.2	71.0	84.3	96.9	76.6	70.6
Schonacher:								
Schonacher	5942	67.1	7.0	96.0	90.0	90.1	41.4	65.3
Seneca Chief:								
Red Cross	3578	67.5	3.1	89.0	80.3			60.0
Seneca Chief	3575	61.5	5.2	92.0	70.0	91.6	77.7	66.3
Sonora:								
Sonora	3036	88.0	56.3	56.0		74.7	46.9	64.4
Do	3622	86.5	60.5					73.5
Do	4293	92.2	71.2	98.0	75.0			84.1
Do	4501	93.9	45.2	52.0				63.7
Do	6018	89.7	54.1					71.9
Do	6023	79.5	54.8					67.2
Surprise:								
California Gem	2986	91.8	60.4	85.0		75.6	62.5	75.1
Do	4248	96.2	54.8	76.0				75.7
White Russian	5277	92.7	63.2	71.0				75.6
Talimka:								
Saumur	2346	87.4	36.9	23.0	45.0			48.1
Talimka	2495	75.8	39.3	27.0	49.0	45.3	42.9	46.6
Taylor's Wonder	6045	44.6	37.9					41.3

TABLE 1.—*Classified list of common wheats, chiefly commercial American varieties, grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in two or more of the years specified*—Continued

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
WHITE WHEATS—continued								
Touse:								
Touse	6017	81.7	56.8					69.3
Do	6019	86.8	78.1					82.5
Ninety-Day	6021	91.4	64.8					78.1
Treadwell:								
Treadwell	5332	79.7	2.9	91.0	50.0			55.9
White Fife:								
White Fife	4412	62.5	34.9	53.0	34.5	26.1	55.6	44.4
Do	4955			35.0	50.0			42.5
White Odessa:								
White Odessa	4480	35.8	1.5	78.0	66.0			45.3
Do	4481–C	.4	0					.2
Do	4651	.7	2.1	1.0	0	1.9		1.1
Do	4655	2.0	2.7	4.0	.7			2.4
White Track	5230	95.5	44.6	94.0	81.0			78.8
Do	5231	86.8	38.5	80.0	65.5			67.7
Do	5267	87.5	55.0	85.0	92.0	93.7	52.3	77.6
White Winter:								
Bishop's Pride	6010	79.7	14.9					47.3
White Winter	4684	88.4	37.9	34.0	81.0	95.5	73.0	68.3
Do	5219	80.5	31.5	75.0	93.0			70.0
Do	5224	86.1	40.4	39.0	93.5			64.8
Do	5232	83.7	71.4					77.6
Windsor:								
Extra Early Windsor	5915	57.3	11.3	56.0	72.0			49.2
Annual average		72.2	35.9	64.9	71.4	67.5	56.8	60.2
Two-year station average		54.1		67.9		62.2		

The data in Table 1 show that nearly all varieties of common wheat are very susceptible to bunt. There is a difference, however, in the degree of resistance possessed by the groups of common wheats when each is considered as a whole. The data are not strictly comparable but are doubtless indicative. The hard red winter wheats are the most resistant, showing an average infection of 22.7 per cent, and the white wheats and the soft red winter wheats with average infections of 60.2 and 58.8 per cent, respectively, are the least resistant. The hard red spring wheats showed an average bunt infection of 50 per cent.

Within each group are found one or more varieties or selections that are highly resistant to bunt. There is a greater number of such resistant varieties in the hard red winter group than in any other, but a few of the more susceptible strains are about as subject to bunt as any of those found in the other groups of common wheat. The very susceptible hard red winter varieties, Alton and Eureka, are awnless and of little commercial importance. If these were omitted the remaining varieties, all belonging to the awned Crimean group and comprising almost all of the commercial hard red winter wheats, would show an average infection of only 10.9 per cent. This is less than that of any other class or species of wheat except einkorn.

Of the entire list of common wheats which were grown in all three States for two years only two remained bunt free. These were Hussar (Red Hussar), C. I. No. 4843, a hard red winter wheat, and Martin (Martin Amber), C. I. No. 4463, a white wheat.

None of the hard red spring wheats was especially resistant to bunt, although Ruby had an average bunt infection of only 11.5 per cent.

Besides Hussar, which was immune, other hard red winter wheats showing a high degree of resistance are Minturki (C. I. No. 6155), Kanred (P–1066 and P–1068), and Rieti (C. I. No. 2578).

Two strains of Odessa (C. I. Nos. 4473 and 6035) were the only soft red winter wheats showing distinct resistance to bunt, and these were grown only at Davis.

Besides Martin, which was immune, other white wheats showing a high degree of resistance were White Odessa (C. I. No. 4481–C), which had an average of 0.2 per cent bunt, and other selections of the same variety (C. I. Nos. 4651 and 4655), which were infected only 1.1 and 2.4 per cent, respectively.

SELECTIONS

In 1916 at Moro, 134 selections of hard red winter wheat were grown in the classification nursery. These were tested for yield in the nursery at Moro in 1917 and 1918 and were sown in the bunt experiments in the fall of 1918. The complete results are not tabulated, but several of the selections proved somewhat resistant to bunt.

Detailed data are shown later (Table 8) for eight of the most resistant of these selections, which were continued in the experiments during the three seasons following.

In the season of 1919–20 seed from 168 head selections of Pacific Bluestem (White Australian) wheat was smutted with spores of *Tilletia tritici* and sown in the experiments at Davis. The original head selections were collected from a large number of fields in the Sacramento Valley in 1917 by J. Allen Clark and E. L. Adams, of the Office of Cereal Investigations. They were grown in the nursery at Chico, Calif., where the seed for these experiments was obtained. The results from this single season's experiments show little probability of finding bunt-resistant strains of this variety through head selection. The lowest percentage of bunt in any selection was 78, and most of them showed more than 90 per cent of infection.

CLUB WHEATS

Data showing the results obtained with club wheats are presented in Table 2. These wheats had an average infection of 68.4 per cent and therefore are highly susceptible to bunt. As a group the varieties are more uniformly susceptible than are the common wheats. The lowest percentage of bunt shown by any variety or selection was 9.2 per cent, by a field selection (C. I. No. 4669) which closely resembles Hybrid 3. The next lowest percentage, 32.3, was shown by Hybrid 3 (C. I. No. 4239).

TABLE 2.—*Classified list of club wheats grown at Davis, Calif., Moro, Oreg., and Pullman, Wash., showing the percentages of heads infected with bunt in the years specified*

Variety	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
Big Club:								
Big Club	4209	87.4	76.9	53.0	96.0	56.3	63.4	72.2
Do	4257	96.6	68.1	44.0	50.0			64.7
Salt Lake Club	3018	88.6	18.3	50.0				52.3
Oregon Club	6028	91.5	63.7					77.6
Bluechaff:								
Bluechaff Club	5178	91.7	67.0	68.0		86.1	57.6	74.1
Do	5256	69.6	57.4	23.0	99.0			62.3
Do	5257	77.8	55.5	42.0	96.0			67.8
Brown Glory	4240	88.9	72.0	84.0		62.5	73.8	76.2
Coppei:								
Coppei	3088	65.5	27.6	75.0	60.0	31.0	65.0	54.0
Do	4238	65.6	30.7	73.0	50.0			54.8
Dale:								
Dale Gloria	4155	91.3	54.3	51.0		71.7	55.4	64.7
Do	4255	85.0	45.6	54.0	33.3			54.5
Do	5902-A	81.6	58.3	68.0	50.0			64.5
Hybrid 3:								
Hybrid 3	4239	34.3	.2	3.0	16.3	85.7	54.4	32.3
Do	4669	1.2	.8	13.0	20.9		10.3	9.2
Hybrid 60:								
Hybrid 60	5024	88.0	66.4	99.0	92.5	98.4	62.7	84.5
Hybrid 63:								
Hybrid 63	4157	84.5	85.0	95.0	95.0	67.4	74.4	83.6
Do	4252	88.3	81.9	78.0	100.0			87.1
Do	4510	80.0	74.7	90.0	95.0			84.9
Hybrid 108:								
Hybrid 108	5025	80.3	58.2	82.0	66.0	63.3	93.3	73.9
Hybrid 123:								
Hybrid 123	4511	77.3	65.8	91.0	60.0	61.9	71.5	71.3
Hybrid 128:								
Hybrid 128	4229	74.7	31.0	82.0	93.5	96.3	83.7	76.9
Do	4257	64.1	19.3					41.7
Do	4512	87.5	35.1	88.0	95.0			76.4
Hybrid 143:								
Hybrid 143	4160	83.0	74.5	95.0	100.0	66.8	79.4	83.1
Do	4513	78.6	69.5	87.0	96.0			82.8
Do	5255	79.5	60.8	94.0	90.0			81.1
Jenkin:								
Jenkin Club	4674	82.0	58.2					70.1
Do	4675	65.5	52.4					59.0
Do	4676	78.6	66.8					72.7
Do	5177	81.2	54.9	46.0		52.9	60.5	59.1
Do	5261	80.2	70.6	85.0				78.6
Do	5903	74.9	68.3	51.0				64.7
Little Club:								
Little Club	4066	92.2	75.6	50.0	90.0	67.3	68.2	73.9
Do	4225	89.6	82.5	73.0	100.0			86.3
Do	5897	95.7	81.2	78.0	97.5			88.1
Mayview:								
Mayview	5874	97.3	77.6	74.0		74.9	63.0	77.4
Oregon Redchaff	4224	88.8	80.1	93.0				87.3
Redchaff:								
Redchaff	4241	93.8	84.4	60.0				79.4
Do	4243	90.5	77.0	58.0		60.9	66.5	70.6
Do	4250	92.6	72.0	41.0				68.5
Do	6041	67.4	43.4					55.4
"Salt Lake Club"	3018-R	85.5	60.6	33.0				59.7
Termok	3720	68.6	54.6	66.0				63.1
Do	4282	73.1	51.7	27.0		42.8	62.0	51.3
Do	4571	77.7	60.1	77.0				71.6
Annual average		79.5	58.5	64.9	76.8	67.4	64.7	68.4
Two-year station average		69.0		70.9		66.1		

DURUM WHEATS

The durum wheats as a group are more bunt resistant than the common and club wheats, except the hard red winter varieties, but showed an average infection of 33.1 per cent (Table 3). There is a wide range of susceptibility, however, between varieties within the group. Kubanka (C. I. No. 2909) and Velvet Don (C. I. No. 2222) in limited tests showed high resistance, but none was bunt free.

TABLE 3.—*Durum wheats grown at Davis, Calif., and Pullman, Wash., showing the percentages of heads infected with bunt in the years specified*

Variety	C. I. No.	Percentages of bunted heads				
		Davis, Calif.		Pullman, Wash.		Average in all station years when grown
		1920	1921	1919	1920	
Acme:						
Acme	5284	67.8	49.1	38.7	38.1	48.4
Adjini	1594	9.5	.8	2.0	30.8	10.8
Arnautka:						
Arnautka	1494	55.9	11.3	11.3	64.9	35.9
Do	4064	43.0	7.4	9.7	56.8	29.2
Do	6174	44.4	8.7	----	----	26.6
Buford:						
Buford	5295	30.6	7.3	13.8	59.9	27.9
Crawford's Hundredfold	----	50.6	37.1	----	----	43.9
Philippino	2888	2.8	0	----	----	1.4
Kahla:						
Kahla	1595–1	65.4	14.4	----	----	39.9
Do	5529	18.6	9.7	6.9	28.6	16.0
Red Swamp	6031	22.6	4.6	----	----	13.6
Sloat	6046	40.7	23.3	----	----	32.0
Kubanka:						
Kubanka	1440	45.4	14.6	17.1	28.0	26.3
Do	2246	49.4	32.8	----	----	41.1
Do	2909	1.9	0	----	----	1.0
Kubanka No. 8	4063	30.8	13.8	9.3	28.8	20.7
Marouani:						
Marouani	1593	21.9	2.7	3.3	58.5	21.6
Do	2235	92.7	70.9	----	----	81.8
Do	2235–1	89.9	74.9	----	----	82.4
Medeah	1597	48.0	0	----	----	24.0
Mindum:						
Mindum	5296	37.5	14.4	14.3	29.5	23.9
Monad:						
Monad	3320	64.2	50.0	33.4	39.9	46.9
Peliss:						
Pelissier	1584	15.5	14.0	2.8	----	10.8
Pentad:						
Pentad (D–5)	3222	73.4	33.8	22.7	50.0	45.0
Piola Karte	2198	79.5	53.9	----	----	66.7
Richi	2089	42.1	17.5	----	----	29.8
Saragolla	2228	47.0	16.5	----	----	31.8
Velvet Don:						
Velvet Don	2222	----	----	4.5	0	2.3
Do	2247	77.0	37.8	----	----	57.4
Yellow Gharnovka	2096	75.2	59.7	----	----	67.5
(No name)	2575	28.0	8.9	----	----	18.5
Annual average	----	45.7	23.0	13.6	39.5	33.1
Two-year station average	----	34.4		26.6		----

MINOR WHEAT GROUPS

Results of the bunt experiments with the minor wheat groups, such as emmer, spelt, poulard wheat, Polish wheat, and einkorn, are given below. Data for the first three of these are given in Table 4.

The data for emmer show that the varieties grown bore 18.5 per cent of infected heads. Emmer is more resistant than common, club, durum, or poulard wheat.

The data in Table 4 show that spelt apparently is slightly more resistant to bunt than emmer. The varieties grown showed an average of 15.9 per cent of infection.

Such poulard wheats as were grown proved more or less susceptible and showed an average infection of 29.8 per cent. Winter Alaska (C. I. No. 5873) showed the least amount of bunt, 6.2 per cent.

TABLE 4.—*Percentage of bunt infection of varieties of emmer, spelt, and poulard wheat grown at one or all of the stations at Davis, Calif., Moro, Oreg., and Pullman, Wash., in the years specified*

Variety	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
EMMER								
Black Winter:								
Black Winter	2337	65.5	12.7					39.1
Khapli:								
Khapli	4013	10.0	6.8					8.4
Red Spring	2484	1.6	46.1					23.9
Do	4573	1.8	0					.9
Vernal:								
White Spring	1524	43.7	4.3					24.0
Yaroslav	1526	49.4	4.0			5.6	0	14.8
Annual average		28.7	12.3			5.6	0	18.5
Two-year station average		20.5				2.8		
SPELT								
Alstroum:								
Alstroum	1773	73.1	11.4			9.2	81.8	43.9
Bearded Winter	1774	43.4	12.4			1.1	35.5	23.1
Black Awnless	4401	37.8	13.3			0	2.0	13.3
Black Bearded	4776					0	0	0
Brown Bearded	4774	2.2	0			.9	27.0	7.5
Red Spring	3064	41.7	12.1			0	8.2	15.5
Red Winter:								
Red Winter	1772	33.2	4.9			0	0	9.5
White Spring:								
White Spring	2968	34.3	.2			1.2	20.7	14.1
Annual average		38.0	7.8			1.6	21.9	15.9
Two-year station average		22.9				11.8		
POULARD WHEAT								
Alaska:								
Alaska	5988	14.8	.6			.4	42.9	14.7
Rivet	4201	51.4	5.6	95.6	22.7			43.8
Titanic:								
Titanic	5535					18.7	11.4	15.1
Winter Alaska:								
Winter Alaska	5873	6.4	3.0			13.5	1.9	6.2
Do	2747	87.4	50.8					69.1
Annual average		40.0	15.0	95.6	22.7	10.9	18.7	29.8
Two-year station average		27.5		59.2		14.8		

Only one variety of Polish wheat (C. I. 3007) was included in these experiments. It was grown for two years at Davis and Pullman. At Davis it had 37.3 per cent of bunt in 1920 and 12.1 per cent in 1921. At Pullman it showed 1.8 per cent of infection in 1919 and 27.4 per cent in 1920. It averaged 19.7 per cent of infection in the four station years grown.

Einkorn (C. I. 2134) was grown at only one station, Pullman, where it remained bunt free in both years. In experiments conducted by one of the writers (W. W. Mackie) at Berkeley, Calif., in 1919, einkorn showed about 25 per cent of infection.

RESULTS WITH AUSTRALIAN WHEATS

Many Australian wheats, principally spring common varieties, were included in the experiments at Davis and Moro. These wheats were grown during two years at Davis and only one year at Moro. The same methods were employed in smutting the seed, sowing, and calculating the percentages of bunt as were used with all other wheats. The results are given in Table 5.

According to the results of the limited experiments presented in Table 5, these Australian wheats appear to be rather uniformly susceptible to bunt. A few varieties, however, show a marked degree of resistance. Among these are Florence (C. I. Nos. 4170, 4988, and 4740), Genoa (C. I. No. 4120), Bathurst No. 2 (C. I. No. 4116), Nardoo (C. I. No. 4985), all common wheats, and the only poulard wheat included in the list, Marster's Perfection (C. I. No. 4726). None of these, however, with the exception of Florence, shows enough resistance, combined with other desirable qualities, to make it highly desirable for use as a parent for hybridization purposes.

TABLE 5.—*Australian wheats grown from smutted seed at Davis, Calif., and Moro, Oreg., showing the percentages of bunted heads in the years specified*

Variety	C. I. No.	Percentages of bunted heads			
		Davis, Calif.		Moro, Oreg., 1919	Average in all station years when grown
		1920	1921		
SPRING COMMON WHEATS					
Alpha	4164	55.0	41.3	79.0	58.4
American No. 8	5134	90.6	72.0	.6	54.4
Avoca	5000	92.6	66.0	76.0	78.2
Bathurst No. 2	4116	14.4	1.9	----------	8.2
Bayah	4165	44.7	17.2	76.0	46.0
Do	5008	60.1	19.9	61.0	47.0
Do	5138	71.7	24.7	----------	48.2
Blount's Lambrigg	5021	----------	----------	96.0	----------
Bobs	4990	81.0	66.5	90.0	79.2
Bomen	4731	31.8	21.5	----------	26.7
Bordier	5063	67.8	44.6	52.0	54.8
Bunyip	4166	51.8	34.4	87.0	57.7
Do	5012	78.5	36.4	52.0	55.6
Do	5125	64.5	39.1	----------	51.8
Cowra No. 3	4119	49.4	35.6	71.0	52.0
Cedar	4117	22.3	5.7	----------	14.0
Do	4737	27.4	26.5	66.0	40.0
Do	4989	19.8	9.7	50.0	26.5
Canberra	4986	74.0	57.6	84.0	71.9
Do	4730	76.2	50.5	95.0	73.9
Cleveland	4118	83.1	53.1	----------	68.1
Do	4732	91.5	54.2	89.0	78.2
Do	5123	94.0	78.5	86.0	86.2
College Purplestraw	5005	92.1	56.2	74.0	74.1
College Eclipse	4998	83.5	56.4	84.0	74.6
Commonwealth	4983	79.6	57.9	51.0	62.8
Comeback	4991	71.1	58.2	78.0	69.1
Do	5979	63.8	35.9	----------	49.9
Correll's No. 3	4999	64.6	28.8	25.0	39.5

TABLE 5.—*Australian wheats grown from smutted seed at Davis, Calif., and Moro, Oreg., showing the percentages of bunted heads in the years specified*—Contd.

Variety	C. I. No.	Percentages of bunted heads			
		Davis, Calif.		Moro, Oreg., 1919	Average in all station years when grown
		1920	1921		
SPRING COMMON WHEATS—continued					
Crossbred No. 28	4987	80.8	55.2	60.0	65.3
Currawa	4982	68.9	45.5	71.0	61.8
Dart's Imperial	4996	85.5	37.1	54.0	58.9
Elephant	2824	79.3	45.7	82.0	69.0
Farmers Friend	2992	97.3	68.9	----	83.1
Federation	4168	62.6	53.4	----	58.0
Do	4734	78.3	57.3	66.0	67.2
Do	4979	80.0	48.3	85.0	71.1
Do	5118	88.8	37.8	----	63.3
Firbank	4169	52.5	33.4	88.0	58.0
Do	5013	67.0	32.1	59.0	52.7
Do	5980	58.4	32.1	----	45.3
Florence	4170	9.9	2.9	16.0	9.6
Do	4740	13.5	4.9	----	9.2
Do	4988	5.5	3.4	22.0	10.3
Do	5129	50.5	76.6	----	63.6
Do	5981	19.8	12.5	----	16.2
Do	----	6.7	0	----	3.4
Do	----	.5	4.4	----	2.5
Gamma	5007	91.6	58.7	67.0	72.4
Genoa	4120	5.0	1.2	----	3.1
Gluyas	5006	76.9	55.5	90.0	74.1
Do	5119	82.8	46.9	----	64.9
Gluyas (early)	4171	55.2	58.6	80.0	64.6
Hard Federation	4733	81.1	68.3	95.0	81.5
Do	4980	95.2	60.8	59.0	71.7
John Brown	4121	72.8	27.2	58.0	52.7
Do	5130	88.9	41.4	47.0	59.1
Jonathan	4122	48.4	31.0	54.0	44.5
Do	4739	58.2	63.0	65.0	62.1
Jumbuck Cross	4729	62.7	31.1	68.0	53.9
King's Early	5139	84.3	51.5	79.0	71.6
Do	5139–2	85.1	51.1	----	68.1
Major	4984	79.8	43.6	72.0	65.1
Marshall's No. 3	4995	74.7	56.3	59.0	63.3
Do	5982	78.1	57.4	----	67.8
Marshall White	5064	91.0	42.4	----	66.7
Nardoo	4985	17.8	16.8	10.0	14.9
Nyngan	5022	80.1	56.7	47.0	61.3
Penny	4993	92.2	73.4	74.0	79.9
Petatz Surprise	5117	91.8	65.0	----	78.4
Purplestraw	4736	69.4	54.0	65.0	62.8
Do	5004	90.5	73.1	53.0	72.2
Redchaff	5068	74.6	40.1	----	57.4
Rymer	4125	75.7	57.2	65.0	66.0
Do	5983	69.2	42.0	----	55.6
Solid Straw Tuscan	----	97.4	69.3	----	83.4
Steinwedel	4172	85.1	69.7	77.0	77.3
Do	4735	82.1	66.0	65.0	71.0
Do	5126	82.8	56.9	60.0	66.6
Sunset	4728	68.2	31.6	76.0	58.6
Do	5984	72.8	51.9	----	62.4
Tarragon	4727	68.7	31.7	78.0	59.5
Thew	4126	57.9	34.3	75.0	55.7
Do	4741	54.6	41.3	65.0	53.6
Do	5002	90.8	53.3	77.0	73.7
Triumph	5003	79.6	61.2	71.0	70.6
"Turkey Red"	5121	58.2	43.8	60.0	54.0
Viking	5009	90.3	48.9	61.0	66.7
Do	5120	92.9	55.1	58.0	68.7
Wagga No. 19	4123	30.4	5.2	54.0	29.9
Wallace	5001	93.3	73.8	77.0	81.4
Warden	4994	85.6	58.4	76.0	73.3
Warren	4725	59.7	54.1	78.0	63.9
Do	5137	78.5	55.4	----	67.0
White Federation	4981	83.7	50.0	86.0	73.2
White Tuscan	5010	87.8	64.1	78.0	76.6
White-Straw Tuscan	5069	71.4	34.0	58.0	54.5
Yandilla King	4174	61.7	48.7	54.0	54.8
Do	4997	77.8	57.6	52.0	62.5

TABLE 5.—*Australian wheats grown from smutted seed at Davis, Calif., and Moro, Oreg., showing the percentages of bunted heads in the years specified*—Contd.

Variety	C. I. No.	Percentages of bunted heads			
		Davis, Calif.		Moro, Oreg., 1919	Average in all station years when grown
		1920	1921		
SPRING COMMON WHEATS—continued					
Yandilla King	5127-a	72.6	37.5		55.1
Do	5127-b	75.4	50.6		63.0
Zealand	5987	79.6	44.8		62.2
Zealand Blue	5011	59.4	18.1	37.0	38.2
No. 4	4718	64.4	54.0	86.0	68.1
No. 9	4719	78.3	61.5	67.0	68.9
No. 3	4720	48.8	35.6	65.0	49.8
No. 14	4721	81.6	54.7	78.0	71.4
No. 8	4722	50.3	42.3	78.0	56.9
No. 11	4723	70.4	47.7	70.0	62.7
No. 2	4724	85.0	68.6	76.0	76.5
DURUM WHEATS					
Cowra No. 16	4738	29.6	18.8	14.0	20.8
Huguenot	4992	44.9	30.5	59.0	44.8
Do	5122	67.2	2.5	61.0	43.6
Nevertire	5020			63.0	
POULARD WHEAT					
Marster's Perfection	4726	12.4	0		6.2

RESULTS WITH INDIAN WHEATS

Seed of a number of selections of Indian wheats was smutted with spores of *Tilletia tritici* and sown at Moro, Oreg., from March 28 to April 9, 1919. Most of these selections became heavily infected in these trials, and none were free enough from bunt to indicate any marked degree of resistance. One selection, C. I. No. 4909, had only 12 per cent of infection. The remainder of these selections showed 34 per cent or more of bunt and are grouped in the following list by their Cereal Investigations (C. I.) numbers according to percentages of infection.

Indian wheat varieties grown at Moro, Oreg., in 1919, listed under their Cereal Investigations numbers and grouped according to percentages of bunted heads

From 34 to 50 per cent infection.—4533, 4561, 4691, 4698, 4699, 4911, 4919.

From 51 to 75 per cent infection.—4527, 4532, 4548, 4549, 4559, 4562, 4563, 4690, 4692, 4695, 4697, 4700, 4702, 4703, 4902, 4905, 4907, 4908, 4910, 4912, 4913, 4914, 4915, 4920, 4921, 4925, 5432, 5438.

From 76 to 96 per cent infection.—4067, 4525, 4526, 4528, 4530, 4531, 4534, 4535, 4536, 4537, 4538, 4539, 4540, 4541, 4542, 4543, 4544, 4545, 4546, 4547, 4550, 4551, 4552, 4553, 4554, 4555, 4556, 4557, 4558, 4564, 4693, 4694, 4696, 4701, 4704, 4901, 4904, 4906, 4916, 4917, 4918, 4922, 4923, 4924, 4926, 5411, 5412, 5413, 5414, 5415, 5416, 5417, 5418, 5419, 5420, 5421, 5422, 5423, 5425, 5426, 5427, 5428, 5429, 5430, 5433, 5434, 5435, 5436, 5437, 5439, 5440, 5441, 5443, 5446, 5447, 5449, 5450, 5453, 5461, 5462, 5466, 5468, 5470, 5471.

The results show that these wheats are highly susceptible to bunt and that it will not be an easy matter to find resistant strains among them. As they are not grown commercially in the United States, it will not be desirable to give them further consideration here.

RESULTS WITH SOUTH AFRICAN WHEATS

Twenty-eight varieties of wheat obtained from different parts of South Africa were grown in the bunt experiments at Davis, Calif., in 1920 and 1921. An unnamed variety, C. I. No. 6165, showed the lowest average infection, 22.5 per cent. All other varieties showed 40 per cent or more. The data are presented in Table 6.

TABLE 6.—*South African wheat varieties grown from smutted seed at Davis, Calif., showing the percentages of bunted heads in 1920 and 1921*

Variety	C. I. No.	Percentages of bunted heads			Variety	C. I. No.	Percentages of bunted heads		
		Davis, Calif.		Average in all station years when grown			Davis, Calif.		Average in all station years when grown
		1920	1921				1920	1921	
Bosjesveld	6118	79.4	64.6	72.0	Rooi Kaal	6070	55.1	59.3	57.2
Dame	6052	80.9	53.0	67.0	Rooi Wolhaar	6107	79.4	65.1	72.3
Du Toit's	6056	76.9	63.5	70.2	Sibies	6071	81.0	52.2	66.6
Early Beard	6075	93.6	78.8	86.2	Talawair	6063	85.0	71.7	78.4
Do	6092	88.0	66.5	77.3	Transvaal Wolhaar	6121	84.4	71.8	78.1
Early Gluyas	6069	47.8	37.9	42.9	Wit Baard	6065	83.0	56.5	69.8
Do	6119	56.3	70.7	63.5	Wolhuter	6073	74.3	46.5	60.4
Geluks	6123	69.1	55.1	62.1	(No name)	6079	82.7	57.3	70.0
Malan's or Spring	6127	69.1	66.9	68.0	Do	6096	85.3	62.9	74.1
Klein	6072	83.8	58.2	71.0	Do	6097	88.6	82.0	85.3
Klein Rooi	6058	83.1	71.0	77.1	Do	6099	83.8	66.4	75.1
Ou Baard	6068	83.4	59.2	71.3	Do	6105	80.9	72.4	76.7
Do	6093	82.7	66.1	74.4	Do	6165	39.0	6.0	22.5
Red Egyptian	6061	66.8	54.2	60.5					

RESULTS WITH MISCELLANEOUS WHEATS

Some selections and varieties have been included in these experiments which do not belong to any of the groups for which tabulated data have been presented. They are not commercial American varieties or varieties from Australia, India, or South Africa. They comprise selections and hybrids made in this country and a few foreign wheats.

Table 7 presents the detailed percentages of infection in these wheats. Most of them are very susceptible. Six hybrid selections show high resistance in a 2-year experiment at Davis, Calif. Three hybrids resulting from a cross between Turkey and Hybrid 128 are very resistant, while three derived from a cross between Turkey and Florence, a resistant Australian wheat, are immune or nearly so. Ridit (see Table 8), the highly resistant commercial hybrid being distributed from the Washington Agricultural Experiment Station, was derived from the cross between Turkey and Florence.

TABLE 7.—*Percentages of infected heads in miscellaneous selections and hybrids of American wheat varieties and a few foreign varieties at Davis, Calif., Moro, Oreg., and Pullman, Wash., in the years specified*

[S. P. I.=Office of Foreign Seed and Plant Introduction]

Variety and synonyms	C. I. No.	Percentages of bunted heads						Average in all station years when grown
		Davis, Calif.		Moro, Oreg.		Pullman, Wash.		
		1920	1921	1919	1920	1919	1920	
Alaska × Jones Fife	6682	4.1	0					2.1
Allies	6136	55.5	14.6					35.1
Allora	1698	93.9	68.1					81.0
Aurore	6135	82.0	74.3			2.5		52.9
Bluestem × Chul	6181	84.2	65.7					75.0
Chul × Bluestem	6180	87.1	63.6					75.4
Abyssinian wheat	2506–1	78.5	58.9					68.7
Do	2507–1	63.5	32.3					47.9
Do	2507–2	64.2	24.5					44.4
Do	2508–2	83.2	37.1					60.2
Do	2511–2	88.8	51.9					70.4
Do	2511–3	76.7	41.3					59.0
Do	2511–5	89.1	40.6					64.9
Persian wheat:								
S. P. I. No. 46592	6193	82.9	38.0					60.5
S. P. I. No. 46593	6194	71.3	43.5					57.4
S. P. I. No. 46594	6195	86.1	20.0					53.1
Koola	2203–2	36.7	18.7					27.7
Kustem	6179	91.9	70.4					81.2
Lebanon	5272	85.1	3.2	71.0	72.3			57.9
Levan	5157	85.8	40.4	99.0	97.5			80.7
Do	5159	88.0	43.2	100.0	80.0	97.0	73.5	80.3
Noe	2683	81.0	38.0					59.5
Quantity	6158	72.2	49.2					60.7
Turkey × Hybrid 128 (Wash. No. 238)		3.9	0					2.0
Turkey × Hybrid 128 (Wash. No. 242)		14.8	0					7.4
Turkey × Hybrid 128 (Wash. No. 247)		8.8	0					4.4
Turkey Red × Florence (Wash. No. 330)		0	0					0
Turkey Red × Florence (Wash. No. 332)		0	0					0
Turkey Red × Florence (Wash. No. 334)		.1	0					.1
Turkey × Jones Fife	6178	80.6	8.5					44.6
"Velvet Node"	4346			61.0	76.0	56.1	64.7	64.5
Do	4349	95.1	52.5	95.0	91.0			83.4
Do	5877	92.6	42.5	83.0				72.7
White Haynes' Bluestem	4963	36.4	7.1			26.0	54.5	31.0
(No name)	4104	70.9	34.2					52.6
Do	4114	90.9	28.4					59.7
Annual average		63.6	31.7	84.8	83.4	45.4	64.2	49.4
Two-year station average		47.7		84.1		54.8		

RESISTANT WHEAT VARIETIES

The extensive experiments on bunt resistance in commercial varieties of American wheats presented in Tables 1 to 4, inclusive, have shown a few varieties and selections to be either immune from or very resistant to the attacks of *Tilletia tritici*. As these have the promise of much economic importance, either for commercial production or for use as parents in breeding experiments, a brief account is given of each.

These wheats belong to three of the five different commercial classes, namely, (1) Hard Red Winter, (2) Soft Red Winter, and (3) White. Hussar, an immune variety (Table 1); Sherman and several other selections from Turkey (Table 8); and Ridit, resulting from a hybrid between Turkey and Florence (Table 8), are hard red winter wheats. Banner Berkeley (Table 8) is a soft red winter wheat. Florence, a commercial Australian variety (Table 8); Martin, another immune selection (Tables 1 and 8); and the strains of the so-called

White Odessa (Tables 1 and 8) are white wheats. There were no outstanding resistant varieties or selections in the Hard Red Spring and Durum classes, and the problem of developing resistant commercial wheats in these classes apparently is more difficult.

Only two of the resistant wheats mentioned here, Florence and Ridit, were bred especially for bunt resistance. The others originated from selections made for other purposes. The discovery of their bunt resistance resulted from the experiments presented herein.

Table 8 contains the detailed results of the experiments with the immune and resistant varieties during two years at Davis, Calif., and during four years for most varieties at Moro, Oreg., and for a few varieties at Pullman, Wash.

TABLE 8.—*Percentages of bunted heads produced by the most resistant varietie and selections of hard red winter, soft red winter, and white wheats grown at Moro, Oreg., Davis, Calif., and Pullman, Wash., in one or more years during the period specified*

[T=Trace]

Class and variety	C. I. No.	Percentages of bunted heads										Average in all station years when grown
		Davis, Calif.		Moro, Oreg.				Pullman, Wash.				
		1920	1921	1919	1920	1921	1922	1919	1920	1921	1922	
Hard red winter:												
Hussar	4843	0	0	0	0	0	0	------	0	0	0	0
Sherman	4430	------	------	3.6	.5	.2	0	------	------	------	------	1.1
Ridit (Washington No. 2324)	6703	------	------	------	------	------	0	0	------	T	0	T
Turkey	6175	8.6	.3	------	------	------	------	2.0	8.0	10.3	5.7	5.8
Turkey Selection:												
No. 1532–1	------	------	------	2.3	.4	5.9	3.3	------	------	------	------	3.0
No. 1558–A	------	------	------	2.8	1.8	3.2	.7	------	------	------	------	2.1
No. 1558–B	7367	------	------		0	1.1	.4	------	------	------	------	.5
No. 1571–C	7363	------	------	6.5	1.0	1.0	0	------	------	------	------	2.1
No. 2576–A	------	------	------	3.6	0	2.0	0	------	------	------	------	1.4
No. 2578–1	------	.2	0	.5	0	1.6	.2	------	------	------	------	.4
No. 2903–5	------	------	------	2.3	0	.6	0	------	------	------	------	.7
No. 3055–A	7366	0	0	1.0	0	.3	0	------	------	------	------	.2
Soft red winter:												
Banner Berkeley	7362	------	------	------	.6	.6	2.2	------	------	------	0	.9
White:												
Florence	4988	5.5	3.4	22.0	4.9	2.2	1.8	8.0	24.0	T	3.0	7.5
Martin	4463	0	0	0	0	0	0	------	------	0	0	0
White Odessa	4651	.7	2.1	1.0	0	.2	0	1.9	3.2	0	0	.9
Do	4655	2.0	2.7	2.1	.7	0	0	------	8.8	0	------	2.0

HARD RED WINTER WHEATS

Hussar (Red Hussar; C. I. No. 4843) is a pure-line selection made from a plat of Hussar wheat at the Illinois Agricultural Experiment Station by C. E. Leighty in 1913. It has proved immune from bunt in all experiments. The original Hussar variety is of undetermined origin, but had been grown at the Illinois station since 1905. It is not very resistant to bunt, as it showed 10 per cent of infection at Moro, Oreg., in 1921.

The selected Hussar is an awned hard red winter wheat having kernels slightly larger and softer than Turkey. The spikelets are easily shattered at maturity. It is of good bread-making quality but has yielded less than several other hard red winter wheats. Because of its immunity from bunt in the Pacific Coast States it is being used as a parent in breeding for bunt-resistant wheats.

Sherman (C. I. No. 4430) is a recently named strain selected by J. Allen Clark from a plat of Turkey wheat at Moccasin, Mont., in 1915. It is similar to Turkey except that it is slightly earlier and taller, has lighter green leaves, the spikes are larger, and the kernels shatter more easily. When grown at Moro this variety appears to be about equal in yield and quality to Turkey, and if later tests confirm these results it can profitably replace Turkey and Kharkof because seed treatment will not be necessary.

HARD RED WINTER SELECTIONS

Several of the most resistant of these selections (Table 8) are typical Turkey in all characters except bunt resistance. Sherman (C. I. 4430), previously described, is one of the most promising of these selections. Other noteworthy selections are Nos. 1558–A, 7367 (1558–B), 7363 (1571–C), and 7366 (3055–A), all of which were pure-line selections made at the Moro station by Carleton R. Ball. Selection Nos. 2576–A and 2903–5 were made at the Amarillo Cereal Field Station, Amarillo, Tex., the former by J. Allen Clark and the latter by Louis Wermelskirchen. Selections of this character promise to replace the ordinary Turkey and Kharkof wheats in sections where bunt is a serious menace, because they can be sown without seed treatment.

Ridit (C. I. No. 6703; Washington No. 2324) is a selection from a hybrid between Turkey and Florence made by E. F. Gaines at the Washington Agricultural Experiment Station. It is an awnless hard red winter wheat with glabrous white glumes. It is the most promising of several selections from the above hybrids which were tested for yield and bunt resistance. It has shown only a trace of bunt in these experiments, and its yields in nursery trials at Pullman also are high.

SOFT RED WINTER WHEATS

Banner Berkeley (C. I. No. 7362) is the result of a hybrid made in 1912 at the Michigan Agricultural Experiment Station between Goldcoin (American Banner) and Turkey (Berkeley). It is a winter wheat having awnless spikes, glabrous white glumes, and soft red kernels. It proved markedly resistant to bunt, and selections made from it by H. M. Woolman appear to be immune. It has given rather low yields in limited experiments.

WHITE WHEATS

The Florence variety was originated by the late William Farrer, of New South Wales, Australia, by complex crosses involving the White Naples, Improved Fife, and Eden varieties. It was developed for its resistance to bunt and was first distributed in Australia about 1907. Florence is a spring wheat having awnless spikes with glabrous white glumes and rather hard white kernels. It is very resistant to bunt but has not proved well adapted in this country. Its value in hybridization is indicated by the highly resistant and immune strains (Table 8) isolated from crosses between Florence and Turkey by the Washington Agricultural Experiment Station.

Martin (Martin Amber; C. I. No. 4463) is a strain apparently identical with the commercial lots of the Martin variety except in being immune from bunt. It originated from a plant selected from a field of wheat near Arbon, Idaho, by Carleton R. Ball in 1915. It is

a tall midtime or late winter wheat having awnless, long, lax, nodding heads and soft white kernels. It is not especially productive or of high quality but is of promise in developing awnless or white-kerneled wheats resistant to bunt.

The so-called White Odessa differs from the Odessa variety principally in having white kernels. It possibly originated from natural hybridization between Odessa and a white-kerneled wheat, possibly Martin Amber. Wheats similar to White Odessa commonly occur as mixtures in fields of Odessa. Three strains of White Odessa were found which showed pronounced resistance to bunt. The one designated as 4481–C was developed from a plant selected from a field of Defiance wheat in Bannock Valley, Idaho, by Carleton R. Ball in 1915. The other two strains were selected from fields of wheat near Preston, Idaho. C. I. No. 4651 was obtained by a member of the Office of Grain Standardization of the Bureau of Markets, United States Department of Agriculture, in a field of mixed wheat, and C. I. No. 4655 by the Franklin County (Idaho) agricultural agent, Mr. Morrison, in a field of Lofthouse wheat.

White Odessa is somewhat late and has awnless tapering spikes with glabrous brown glumes and soft white kernels. It is rather winter hardy.

SUMMARY

Bunt causes severe losses to the wheat crop, especially in the Pacific Coast States. In that region seed treatment often is ineffective in controlling bunt because of soil infestation, and the standard liquid treatments frequently cause losses due to seed injury. The growing of wheats immune from bunt would prevent these losses and save the trouble and expense of seed treatment.

Seed of one or more strains of nearly all of the commercial varieties of wheat grown in the United States was smutted with spores of *Tilletia tritici* and sown during two years in nurseries at Davis, Calif., Moro, Oreg., and Pullman, Wash. Numerous foreign wheats and selections from other domestic varieties also were grown in these bunt experiments.

Nearly all varieties of American wheats, all but one of the Australian wheats, and all of the Indian and South African wheats are more or less susceptible to bunt.

Of the four commercial classes of common wheat, the hard red winter wheats are the most resistant, and the white wheats as a class are the most susceptible, although one variety and four selections proved to be immune or highly resistant. The hard red spring and soft red winter varieties are somewhat intermediate in susceptibility. One of the soft red winter varieties, however, proved to be highly resistant.

The club wheats as a group are the most susceptible to bunt. The durum, Polish, and poulard wheats as well as emmer and spelt in general are somewhat more resistant than the common wheats except hard red winter, which is more resistant than durum and poulard. Einkorn in these experiments developed no infection, though in some studies conducted at Berkeley in 1919 it showed 25 per cent of bunt.

Only two common wheats, Hussar (C. I. 4843) and Martin (C. I. 4463), proved immune from bunt in these experiments. Three

strains of White Odessa, nine selections from Turkey, and the Ridit, Florence, and Banner Berkeley varieties are highly resistant to bunt.

The immune strains of Hussar and Martin are of great promise for the development of bunt-resistant wheats by hybridization, although they are, in themselves, of little commercial value.

Limited yield experiments with Ridit, a hybrid between Turkey and Florence, indicate a possibility of its becoming a valuable commercial variety.

The resistant selections of Turkey, including one recently named Sherman, can safely be sown without seed treatment. These selections appear to be practically equal to the original Turkey in yield.

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